

Shale, the new oil swing producer?

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Bachelor of Science HES in International Business Management**

by

Gregory HUTIN

Bachelor Project Advisor:

Benoit LIOUD

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Declaration

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Gregory HUTIN

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Executive Summary

Only a few years ago, as the world's supply of oil was showing evidences of peaking, it was almost certain that the world was slowly running out of its main source of energy. It was certain that the world needed to prepare for a peak oil situation, and prices were breaking records again and again.

From this situation emerged a new player in the oil industry that has changed the oil market for the next decades: the US tight oil, also known as shale oil, industry.

This revolution was made possible by the high prices of the years 2008-2014 as well as a favorable environment: low interest rates allowed the shale companies to finance themselves for cheap, mineral rights are guaranteed by law, and the country's need for energy independence gave political support to this industry.

From only a few thousand barrels per day in the beginning of this century, the tight oil industry grew swiftly, and produces today about 4.75 million barrels per day, which is more than Iraq, the fourth biggest producing country in the world.

Obviously, this new player shook up the oil industry, and reshuffled the cards in the oil market. OPEC, and particularly Saudi Arabia, the biggest crude oil producer in the world, which has been able to influence global price of oil, is losing slightly its market power. This led to a significant change of strategy for the "oil cartel", which decided in 2014 to maintain production levels and maintain their market share rather than cutting it to maintain high prices.

This research focuses on the status of the swing producer, the producer that has this capacity of balancing the market of oil, preventing shortages or gluts. This "role" that has been held by Saudi Arabia since the 70's, is now appearing to shift to the American shale producers. This study will present the actual state of the shale industry, to get a better understanding of the dynamics involved in this particular player in the oil market. Then, it will assess the characteristics of the swing producer and review of the previous swings of the global oil market.

Then, it will analyze the implications of this new situation on the oil market. New varieties of crudes are available on the market, and the trade flows of both crude and refined oil products are changing.

By analyzing how shale oil is reshaping the oil industry, it will finally assess the implications of this new situation for the market, both today and in the future.

By gathering and analyzing data and reports from the industry, specifically major factors such as prices, inventories, forward curves and trade flows, this study has come to the following conclusion:

- The shale industry, while having different characteristics compared to the previous swing producers, is the new price maker of the oil market.
- The emergence of this new player changed the rules in the oil game and forced conventional producers such as OPEC to adapt
- The market is Entering a cycle of low prices that could last for years

This research does not cover all the aspects linked to the shale industry. Therefore, it does not address concerns such as the potential pollutions caused by fracking activities. While these matters are relevant for someone who wants to assess the ecological impact of the shale industry, it is not in our opinion pertinent in the focus of our research.

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1. Introduction

1.1 *History of shale oil*

Crude oil, commonly referred to as petroleum or fossil fuel, is a liquid composed of hydrocarbons that is found in reservoir rocks. These reservoirs are geological formations which are permeable enough for the oil to flow. To be brief, when a producer wants to extract oil from these reservoirs, a hole needs to be drilled to access the oil. Then, a pipe is placed in the hole through which the oil is going to flow to the surface.

Tight oil (also known as shale oil) on the other hand is found in low permeability reservoirs and is more difficult to extract. The extraction of tight oil is done through a process called hydraulic fracturing or “fracking”. In this process, after drilling vertically into the ground like in conventional wells, the producers drill horizontally into the rock and then use high pressurized water mixed with sand and chemicals to frack the rock, opening fissures that allow the oil trapped inside of the rock to escape and flow into the borehole. Fracking, by its complexity is more expensive than the extraction of crude oil.

The wide varieties of crude produced around the world (density/sulfur content) have their specificities that differentiate one from the other. The quality of a crude can be measured with two characteristics that are its density (measured in API) and sulfur content.

Density of a crude can be referred to as light or heavy, and sulfur content is described as sweet or sour. Light sweet crudes are usually sold with a premium compared to heavy, sour crudes. This comes from the distillation process of the crude and the end-products obtained: a light sweet crude will be easier to distillate and requires refineries that are less sophisticated and energy-intensive processes and give distillates that are more profitable, such as gasoline or diesel fuel, compared to a heavy sour crude that need specific refineries, has a higher impact on the environment, and give less desirable distillates.

The oil extracted using the fracking process can have a wide range of API gravity and sulphur content, but is mainly light oil, which we will see later creates new challenges and opportunities when it comes to transportation and refining.

This process, while allowing access to oil and gas that would not be reachable with traditional extraction methods, is much more complex and costly than the process used to access conventional oil. For these reasons, the production of shale gas and oil was insignificant until 2006-2007, when high oil prices and technological progress created an incentive to extract oil from shale rocks. Since then, the production grew rapidly, from less than 400'000 barrels per day in 2006 to about 4.1 million barrels per day in 2016, according to the U.S. Energy Information Administration¹, which represents more than half of the total U.S. crude production.

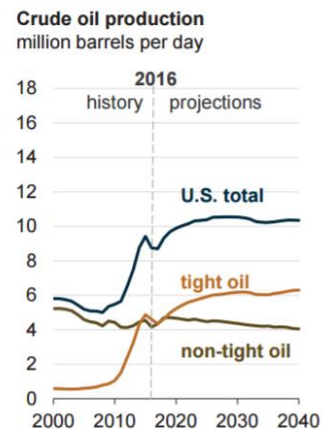


Figure 1: U.S. oil production
(Source: EIA 2017)

Until now, the production and trade of tight oil was mainly limited to the United States who is accountable for more than 91% of the world's tight oil production², but wider reserves are proven to exist in the world

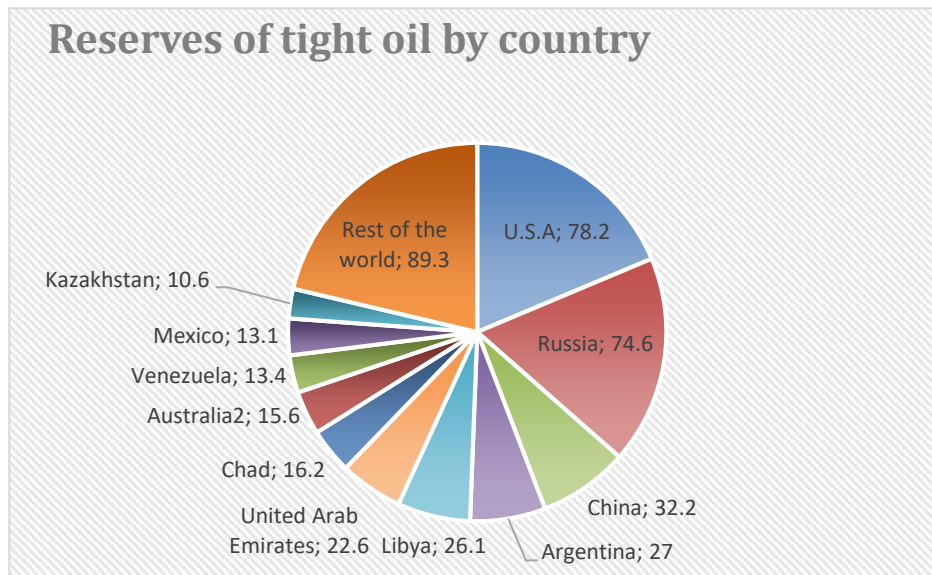


Figure 2 : Reserves of tight oil by country (Source: EIA 2017)

¹ U.S. Energy Information Administration, 2017. EIA

² Ref 1.

1.2 Dynamics

When conventional oil wells decline at around 6% per year, Tight oil wells decline usually at a rate of 60% in the first year and 25% in the second year. The result of the fast decline of the productivity of tight oil wells is that the industry has to drill and operate wells at a faster rate than in conventional fields.

Moreover, the relative short term of the production cycle of a shale well implies in theory that shale producers should be more responsive to price signals than conventional oil producers.

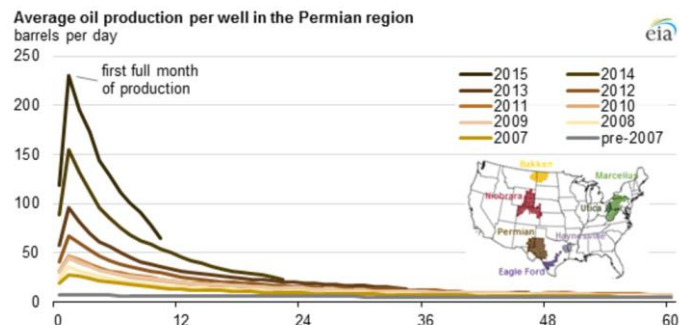


Figure 3 Average oil production per well in the Permian region
(Source: EIA 2017)

1.3 The US shale oil Industry

The shale oil industry is roughly 10-12 years old, when production costs and high prices allowed it to become profitable.

As stated before, the U.S. production of tight oil started to become significant between 2006 and 2008, when oil prices went up to historical highs (the West Texas Intermediate, the American benchmark for oil price broke the 140usd/bbl price point). During this

U.S. petroleum consumption, production, imports, exports, and net imports

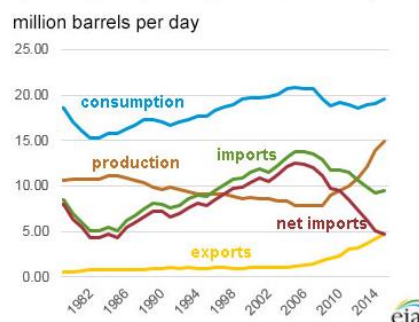


Figure 4 U.S. petroleum consumption, production, imports, exports, and net imports (Source: EIA 2017)

period, the United-States imported more than 12 million of barrels of crude per day³ while producing between 5 and 6 million barrels per day.

This tight oil boom, while allowing the United States to reduce their dependency on petroleum imports, enabled the country to become an important exporter of petroleum products (gasoline and diesel fuel mainly).

But the shale industry, unlike conventional oil producers, which are mainly big multinationals or national oil companies (NOC), is composed of many smaller companies (fragmented), that produce from a few thousands up to 250'000 thousand barrels per day. The size and influences of these companies have a direct impact on the industry's dynamics, with its qualities and defaults. These impacts are going to be developed in another chapter.

The boom of the U.S. shale production has been mainly driven by three shale plays (regions): Eagle Ford, the Permian Basin and Bakken. These three areas have had a huge impact on the increased volumes of crude produced in the United States during the development of the tight oil industry, accounting together for 89% of the total tight oil production in the United States⁴.

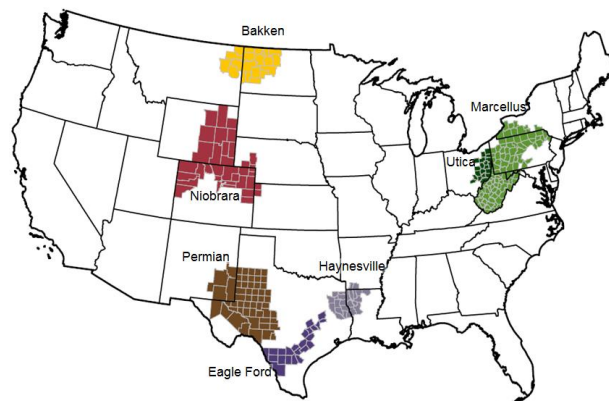


Figure 5 Key tight oil and shale gas regions (Source: EIA 2017)

³ U.S. Energy Information Administration, 2017. *EIA*

⁴ Ref 3.

1.3.1 The Bakken play

The Bakken-THREE Forks tight oil play is a part of the Williston Basin, which is located across North Dakota, Montana and the province of Saskatchewan in Canada.

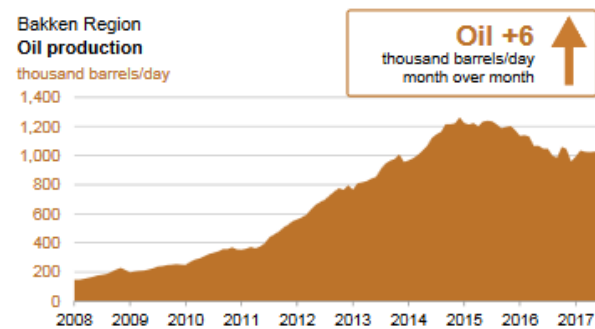


Figure 6 : The Bakken play oil production (Source: EIA 2017)

The Bakken play has been the first to face

a major increase in the production at the beginning of the « tight revolution ». Oil was first discovered in the region in 1951, and opened the door to the U.S. shale boom when an attempt of a combination of horizontal drilling and hydraulic fracturing showed promising results and highlighted the possibility that tight oil reservoirs could be economically effective.

Production in the Bakken shale oil play represents currently a million barrels per day, and according to the EIA, the Bakken region's proved reserves of oil are as high as 5 billion barrels.

The basin is today the most mature of the tight oil plays in the USA. Maturity of a tight oil play is defined as “the amount of time during which producers have been drilling and producing from it using unconventional techniques such as horizontal drilling and hydraulic fracturing.”⁵

The play's production mainly relies on 10 major producers, who could lock up large areas of production when the shale rush began. These 10 producers are responsible for 75 to 80 percent of the total play production.

1.3.2 The Permian Basin

Located in West Texas and extending to the south-east of New Mexico, the Permian Basin is approximately 250 miles wide and 300 long. The drilling in the Permian Basin began nearly a century ago, and the basin has produced nearly 30 billion barrels since the beginning of its exploitation. A production decrease started from the 1970's until fracking started to be used. The development of fracking reversed the basin's production

⁵ CURTIS, Trisha, 2016. *The Oxford Institute for Energy Studies*

decline, transforming it into a mixed conventional/unconventional oil play. The area's activity surged when oil started to be extracted in significant quantities with the use of these new processes.

With a production of more than 2.4 million of barrel per day, the Permian Basin is the biggest oil producing region of the United States, and a bigger oil producer than countries like Qatar and Angola. The strength of the production of the basin comes from various characteristics: the region contains important reserves of oil and gas. Oil reserves, as estimated in 2016, amounted to approximately 3.7 billion barrels⁶, and an assessment of the United States Geological Survey agency (USGS) estimated that the undiscovered and technically recoverable oil reserves in the “Wolfcamp” part of the basin (one of the six most producing region of the Permian area) were as high as 20 billion barrels⁷. Nevertheless, these data are not showing the economic recoverability of the project that would need further prospects to be evaluated, but it shows that the Permian region has still a significant amount of reserves.

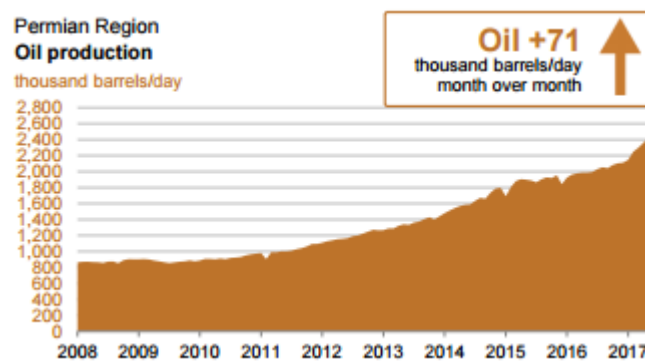


Figure 7 : Permian Region Oil production (Source: EIA 2017)

Finally, Permian Fields are among the most profitable shale fields, some of them having a break-even price of 30USD, according to Pioneer Natural Resources Co.'s Chairman Scott Sheffield⁸

⁶ BERMAN, Arthur, 2017. *OilPrice*

⁷ United States Geological Survey Agency, 2017. *USGS*

⁸ CAROLL, Joe, 2016. *Bloomberg*

1.3.3 Eagle Ford

The Eagle Ford's shale activity is much younger than the two other regions presented above, but after the first wells were drilled in 2008, the play's production quickly ramped up, reaching a production of 1 million barrel in less than 6 years and peaked at 1.6 million barrels per day before slowing down in 2015. As we will see later, the reduction is mainly due to the fall of prices that started in 2014, but the production is recovering since the beginning of 2017.

Proved reserves in 2015 were of 4.3 billion barrels of crude in the region, making it the second biggest U.S. shale reservoir until today but higher costs of production in the region (break-even price in Eagle Ford is around 50USD per barrel, much higher than the 30USD price needed in the Permian region) affected the production of the play more heavily than the other major tight oil plays.

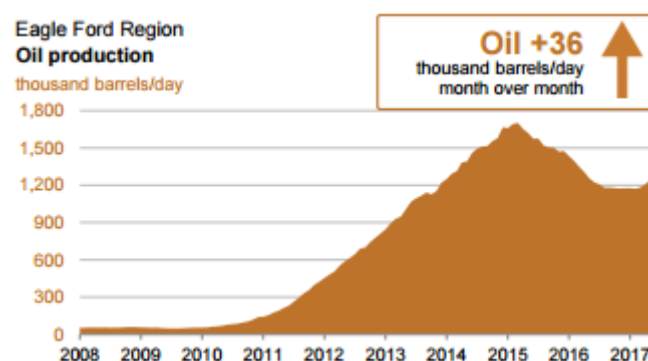


Figure 8 : Eagle Ford Region Oil production (Source: EIA 2017)

1.4 The tight oil Boom

Since almost a decade, the shale industry had a major impact on the global energy business. In 2007, the US oil production started to raise for the first time since the peak production in the 1970s (see fig.1). This increase occurred after the production fell to 5 million barrels per day. Today, the production is outperforming and back at around 9 million barrels per days. It is expected that the US production exceeds Saudi-Arabia's one and that the country become the world's biggest producer of oil before the end of the decade⁹.

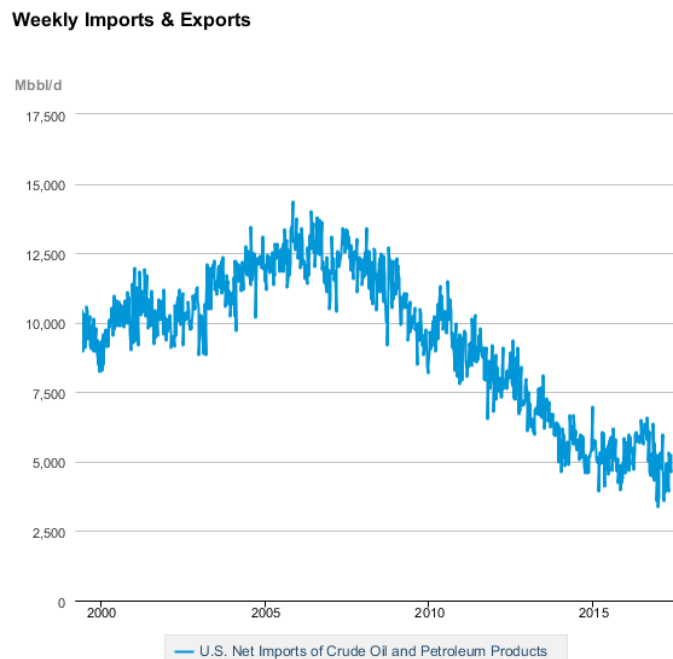
The United States became a net exporter of Petroleum products (gasoline, diesel and other oil distillates) in 2011, thanks to the increase of the oil output inside the country¹⁰.

⁹ U.S. Energy Information Administration, 2017. *EIA*

¹⁰ Ref 8

The increase of the US production could also lead the country to be a net exporter of oil in the 2030's, according to the EIA. The Congress decided in December 2015 to lift the ban on crude oil exports that had been in place since the embargo imposed by the Organization of Petroleum Exporting Countries (OPEC) in response to American aid to Israel during the Yom Kippur War in the 1970's.

This decision may have significant impacts on the global oil market. According to the American Foreign Policy Council, being self-sufficient and export crude allows the US to reduce its dependence on oil coming from the Middle East, improve the security of its energy supply, partners and allies.



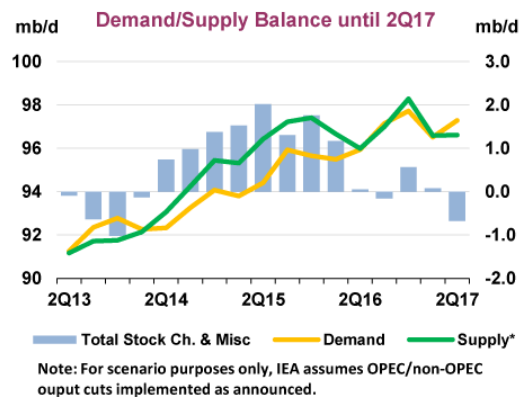
Source: U.S. Energy Information Administration

*Figure 9 : U.S. Net Imports of Crude Oil and Petroleum Products
(Source: EIA 2017)*

The Shale revolution, by reducing America's need for importation of crude, is reshaping global oil markets. The surprisingly high amount of oil that producers can extract from shale formations, linked with their capacity to increase quickly the production and

respond to price incentives, is re-orienting the market toward a “demand-driven” situation.

Furthermore, until a few years ago, the common view was that global crude production



*Figure 10 : Demand/Supply balance for crude oil
(Source: EIA 2017)*

would not be able to keep up with the growing needs, particularly with the development of emerging countries. Some would even say that we were reaching the global “peak oil” moment, when global production would start decreasing.

The rise of the worldwide crude production, in the U.S, but also the Canadian Oil Sands and more traditional producers such as Russia and Gulf-countries proved that there was still crude to be pumped for many decades, if not centuries, if the price was high enough.

The possibility to see America flood the market with its tight oil is good news for end consumers. They should, at the end, be the biggest winners of this situation. The market contains more actors which mean more diversified source of oil and more balanced supply and demand. This structure leads to less volatility and lower prices, but the situation threatens oil producers, who would suffer from a loss of power, market share and falling prices.

But if we look back at the beginning of the decade, the WTI spot price was consistently between 90USD/bbl and 110USD/bbl, due to various factors such as the geopolitical situation in the Middle East, more precisely in oil producing countries such as Libya, Iraq or Iran. These issues led to a global supply shortage. The supply shortage linked to the low financing costs (interest rates have been historically low since the financial crisis of 2007) created the perfect conditions for a rapid expansion of the tight oil industry: The producers could borrow the vast amounts of money they needed to start their drilling activities and were assured to be profitable.

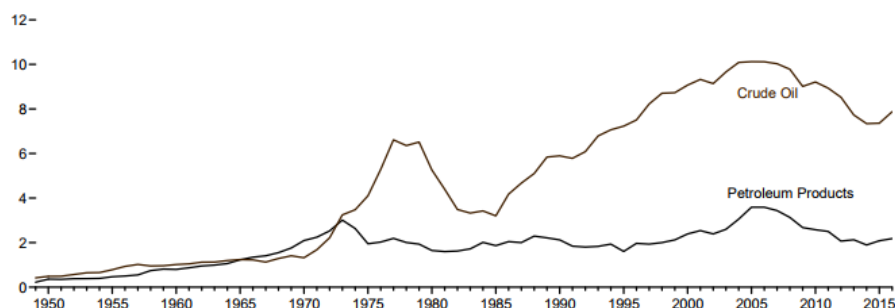
Thus, the U.S. domestic production took off, and as shown previously, the quantity of crude imported in the country decreased significantly.

The fall in U.S. crude imports, even if it had smaller implications in the global market due to the ban-export that was lifted only recently and the fact that the U.S. is still importing a large amount of oil, was inconvenient for the conventional oil-exports dependent countries, such as Saudi Arabia. The loss of significant demand from a reliable importer as are the U.S. (imports from OPEC Countries to the United States fell from nearly 6 million of barrels per day in 2008 to a historically low 3.2 million of barrels per day in 2014) was a threat to OPEC's exports.

Moreover, the large amount of crude that emerged from the fracking boom decreased significantly the price of domestically produced oil. The U.S. refiners had therefore access to low-priced crude, which inherently increased their production and exports of refined products, mainly gasoline and diesel, to Europe and Latin America (as distilled products were not subject to the export-ban). These countries having access to cheap refined products didn't need as much crude for their own refineries, the imports of crude from the middle-east was reducing, threatening even more Arab oil's market share. Add to that a slowing global demand and we can see that the prices (100 USD and more) of the beginning of the decade were not sustainable.

Figure 3.3b Petroleum Trade: Imports
(Million Barrels per Day)

Overview, 1949–2016



OPEC and Non-OPEC, 1960–2016

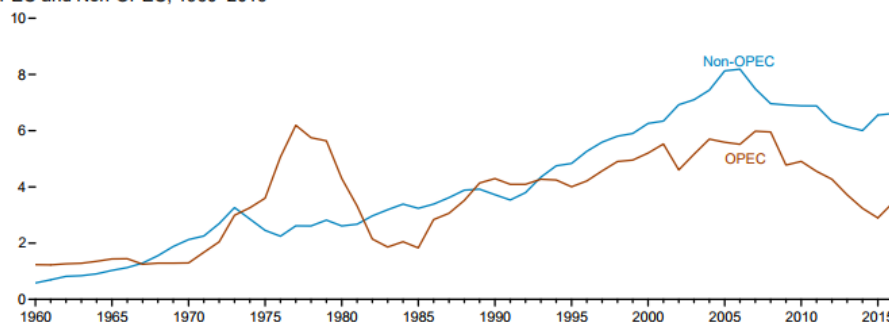


Figure 11 : Petroleum trade: US imports (Source: EIA 2017)

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The perspective to see this new player gaining a high market share in the global oil market was no good news for OPEC members, who are heavily dependent on oil exports to fuel their economy and balance their state budgets. Thus, when the prices started to fall in the middle of 2014, while everybody would have thought that OPEC was going to restrict their supply to the market to push the price up, they decided at their 166th meeting in November 2014 not to reduce output and to go for market share rather than preserving revenues.

The aim of the strategy was not only to preserve OPEC's countries market share, but also to "kill" the unconventional producers who had traditionally higher costs of extraction. At that time, shale's extraction break-even costs were as high as 80USD/barrel, when Saudi's field costs of extraction were in the 5-10USD/barrel range. This was the beginning of the "price war" in the oil market which is still not over today.

1.5 The price war between US shale and OPEC

For Ali al-Naimi, Saudi Arabian Minister of Petroleum and Mineral Resources, it was a matter of time before the U.S. shale companies would grab enough market share to threaten Saudi Arabia's revenues. To prevent this to happen, it was decided not to cut production.

Production cut had, in the past, been followed by OPEC members with little to no commitment, most of the countries are reducing less than agreed or even not reducing their production at all. Therefore, it was unlikely that Saudis would push for a production cut that they would be the only one to follow, reducing in the same time their market share and revenues.

After the announcement, the oil price that started to decline steadily since the middle of 2014, crashed in the beginning of 2016, bottoming at less than 30 USD/barrel

Shale producers didn't start to suffer from these low prices before the middle of 2015 because the production had been hedged against the price risk, giving them a bit of time before beginning to be harmed by the low prices. In the meantime, OPEC members, that received most of their state income from their national oil companies, encountered an important fiscal deficit, and had to use their reserves of foreign exchange to fuel their economies. Countries like Venezuela started to face severe political issues and even the Saudis, who had low production costs and generous reserves, could not stand this

situation for a long period. In fact, OPEC's net oil export revenues fell from 933.5 billion USD in 2014 to 433.4 billion USD in 2016¹¹.

U.S. oil production started to decline in June 2015, giving good hopes that Shale producers could be forced out of the market. Investment in oil exploration and production (E&P) in the United States fell by nearly 40%, followed in its fall by the number of rigs in operation, who went from 1539 in the end of 2014 to 330 in the middle of 2016.

Although, the OPEC didn't anticipate in their strategy the resilience of the U.S. tight producers. To survive, the tight oil industry had to become leaner and more efficient and the smaller companies who had a lower well performance, were the first to stop their activities, causing indirectly the average productivity to go up¹². Then, the companies focused on exploiting the most productive wells, whereas before the price collapse the goal was to drill a maximum of them, without looking at efficiency.

Finally, tight producers managed to make important efficiency gains on drilling and completing costs as well as reducing frack wastes. Those factors being combined, led the shale industry to become viable in a low-price environment.

Therefore, even if service costs are expected to increase in the near future, there is no reason to expect that the industry will not survive after the price war.

¹¹ U.S. Energy Information Administration, 2016. *EIA*

¹² Ref 5.

On the other side, the low prices proved to be very costly for OPEC members, as they rely heavily on oil exports, and by extension on oil price. Their state budget being mainly constituted by oil revenues, a whole part of their income disappeared in a short period.

OPEC member	Fiscal break-even price	Fiscal deficit (% GDP)	Million barrels per day	Spare capacity (% unused)
Algeria	\$96.10	-13.90%	1.11	2.63%
Angola	\$110.00	-3.50%	1.79	2.22%
Ecuador	n/a	-5.10%	0.53	5.26%
Iran	\$87.20	-2.90%	2.88	20.83%
Iraq	\$81.00	-23.10%	4.2	6.94%
Kuwait	\$49.10	1.20%	2.73	1.42%
Libya	\$269.00	-79.10%	0.43	20.00%
Nigeria	\$122.70	-2.80%	1.9	6.77%
Qatar	\$55.50	4.50%	0.67	5.71%
Saudi Arabia	\$105.60	-21.60%	10.25	17.13%
UAE	\$72.60	-5.50%	2.89	2.04%
Venezuela	\$117.50	-24.40%	2.38	3.21%

Figure 12 : Fiscal break-even price for OPEC member countries (Source: CNBC 2015)

The situation was therefore more dangerous for OPEC members than it was for the American, and when Al-Naimi retired in 2016, his successor, Khalid Al-Falih, decided to reverse the strategy that proven to be very costly and to push for production cuts in the cartel. The cuts were negotiated and announced at the end of 2016. The cartel, with other non-members like Russia, announced a reduction of about 1.8 million barrels.

This announce, while pushing Brent price overs 50USD, did not seem to have a major impact like past cuts had. It highlighted a new situation in the market: OPEC could have lost its ability to influence the market and the prices by adjusting its output. The following part of this research will address whether OPEC, and by extension the Saudis, are still the “Swing” producers on the oil market, or if the shale industry changed the balance of power in the market sufficiently enough to remove these characteristics and become the new “Swing”.

2. Analysis

This chapter will first define what is a “swing producer”, what are the characteristics that a producer needs to have to be considered as swing and the implication for the market to have a swing producer or none. Then I will try to analyze whether the U.S. shale industry is or is not able to act as swing on the market.

Regarding the definition of a swing producer, the ARC Energy Research Institute describes it as: “a supplier that has a large amount of spare capacity; so much so that they can influence market prices by ratcheting their output up or down at will.” Swing producers therefore act as market regulators, by balancing the supply to meet the demand, and therefore to keep the prices high and stable.

A swing producer aims to keep the price high enough to take the most profits, but in the meantime, keep it under a certain ceiling to discourage alternatives. By doing that, the swing producers reduce volatility.

2.1 **Characteristics of a swing producer**

2.1.1 **Market share**

Indeed, to be able to have an impact on the global supply and be considered as swing, a producer should have a market share that is high enough to influence the global supply. As the world’s leaders in oil production, the United States Russia and OPEC/Saudi Arabia are the three countries that are the most likely to have the critical mass needed to have the ability to influence the global oil price, with the exception of unpredictable events such as major supply disruptions that could happen, for instance, during a war.

As said previously, regarding the market share on crude oil production, there are three major players within the industry. Russia and Saudi Arabia account each for 13% of the global production, whereas the United States are a bit below and have 11% of the market share. Finally, OPEC’s market share is of 44% (2017 data). These relatively big percentages of global production enable these three countries and the OPEC to be the key influencers in the market.

Focusing on tight oil production, the United States accounts for 92% of the total production (4.1 million b/d in June 2016). Canada which is the only other producer and produces 0.38 million b/d in January 2016)

2.1.2 Spare capacity

The spare capacity of a country or region has a crucial role in its ability to meet the demand. According to EIA, the definition of this term is: “an output that can be turned on within 30 days and sustained for at least 90 days”. Spare capacity is mainly used when the market faces a supply-demand imbalance following several unexpected events such as natural disasters, crisis and wars. This means that a country that has the capacity to quickly supply a significant amount of oil is able to stabilize the market.

Having a sufficient spare capacity is essential for a producer to be considered as swing, because without it, it is impossible for a producer, even the biggest, to balance the market.

OPEC always applied a strategy that consists of producing a high level of oil and simultaneously maintaining an optimal spare capacity. Some external factors influenced the levels of spare resources such as the non-OPEC countries production increase. In such trends, the supply Shifts upwards and the spare capacity is not consumed.

As we can see in figure 13, OPEC's spare capacity varied widely from one year to another in the last 16 years. It was low when prices were high, showing the cartel's goal of ensuring that the market was well supplied, and high when prices were low, showing production cuts, to support prices.

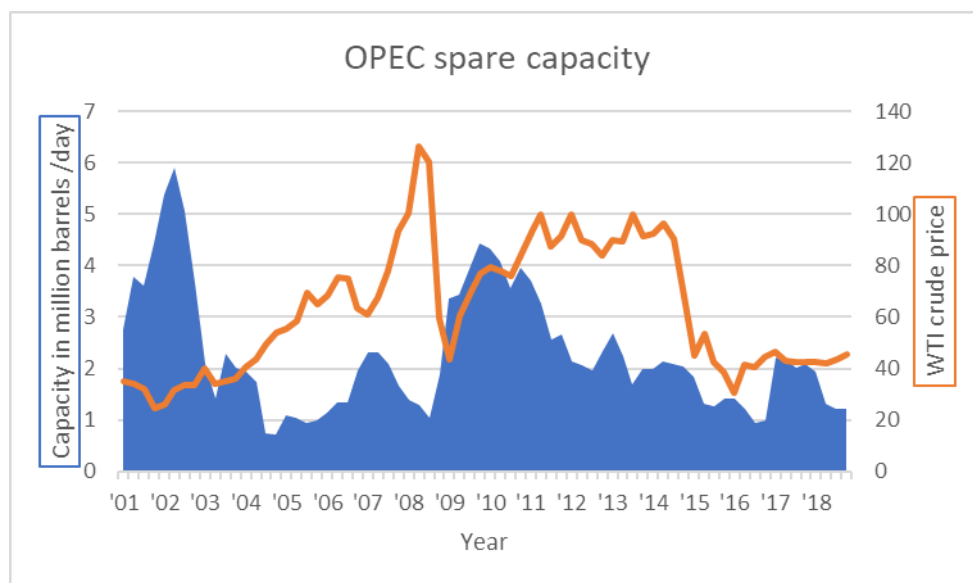


Figure 13 : OPEC production spare capacity (Source: EIA 2017)

2.1.3 Low production costs

To be swing, the producers need to have low production costs. Being able to diminish these costs, allows the producers to stay profitable even if the prices are weak and thus, being still able to influence the market.

As we can see in figure 14, Middle East producers tend to have the lowest production costs (per barrel). Shale producers, by being on the upper side of the curve, could be seen as less able to operate when prices were not high enough. When the prices dropped in 2014, the shale industry was expected to suffer massively and that it would lead to an output reduction.

Stylised oil production cost curve

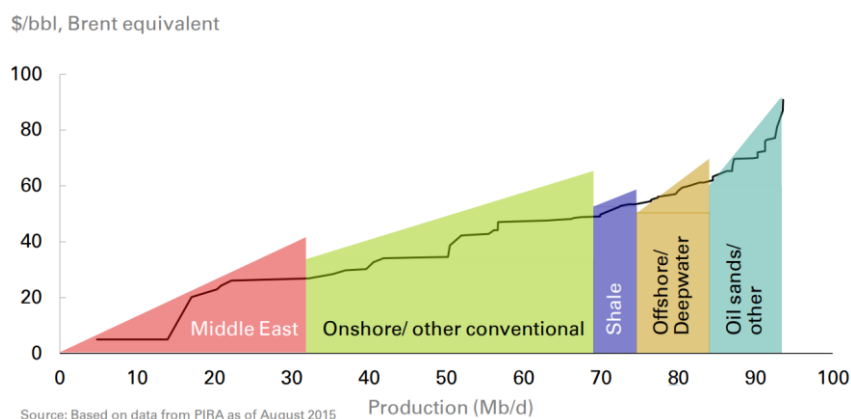


Figure 14 : Oil production cost curve (Source: BP energy outlook 2015)

But it didn't happen. Contrary to expectations, shale producers were able to drive their costs down. Several factors led to this situation, for instance, improvements in the exploration and fracking methods. Some companies were even able to "re-frack" already used wells with new techniques.

Frackers are now able to find the most profitable places to drill, i.e. the wells that will give the most of oil for the lower price, which has a significant impact on the cost curve.

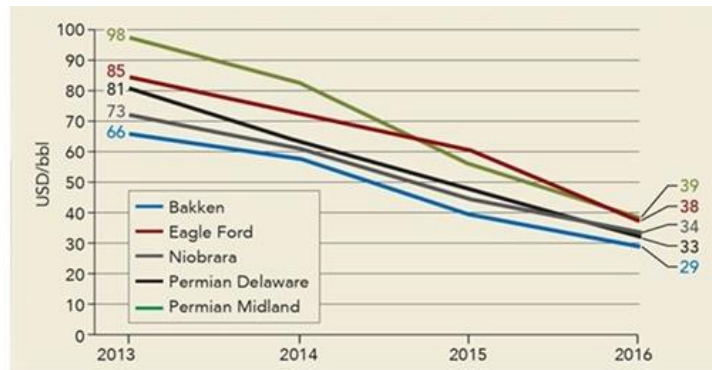


Figure 15 : Development in wellhead breakeven price for key shale plays (Source: Rystad Energy NASWellCube 2016)

2.2 Historical swing producers

2.2.1 1930's to 1970's: the Texas Railroad Commission

To better understand the role of a swing producer, we can take a look at the past, when the US oil industry used to regulate the oil supply to match the demand, and therefore, keep prices stable.

At the end of the 1920's, the development of the worldwide oil production led to an oversupply that was threatening the whole industry. The price fell as low as 10 cents per barrel in mid-1931, which forced the US government, who was trying to restore the industry after the 1929 crisis, required the Texas Railroad Commission (TRC) and other oil producing organizations to put in place oil production restriction to equilibrate supply and demand in the market. TRC was then responsible for the control of most of the spare capacity of the US industry¹³.

At the time, posted price of oil in each country considered the freight expenses from the crude's production plan to the US gulf coast. It allowed to have a more transparent and comparable price.

By controlling the amount of oil produced in Texas, TRC had a major grip on the US spare capacity and by extent, on the US gulf coast posted price. Consequently, TRC had the ability to exercise control on the global crude price.

By balancing the supply, and as long as the US spare capacity was important enough to adjust it to the demand, TRC was acting as swing producer. This situation lasted from the 30's until the 70's, when the American oil production peaked before starting to

¹³ DOWNEY, Morgan, 2009. *Oil101*.

decrease, when the “peak oil” happened. At this time, North American producers were no longer able to adapt their production to the demand, and therefore lost the ability to regulate the market and the price. A rather new player in the market took over the role of swing producer: OPEC

2.2.2 1970’s: OPEC’s rise as the new swing

Founded in 1960 by Iran, Iraq, Kuwait, Saudi Arabia and Venezuela, OPEC’s goal is to “co-ordinate and unify petroleum policies among Member Countries, in order to secure fair and stable prices for petroleum producers; an efficient, economic and regular supply of petroleum to consuming nations; and a fair return on capital to those investing in the industry”¹⁴. The countries at the origin of the organization wanted to unite to gain better power over the market and over the major oil companies, in order to obtain better prices and greater share of the benefits created by the oil production.

The power of OPEC over the oil market appeared in 1973, during the Yom Kippur War, when the organization placed an oil-export embargo on the United States for supporting Israel in the war. The embargo pushed the price of crude from 3 usd/bbl up to 12 usd/bbl from September 1973 until March 1974, leading to what would be called later the “first oil shock”.

The first outcome from the embargo was that OPEC was the new swing producer in the oil market. The second one was that while oil demand is quite inelastic in the short-term, sustained high prices lead oil consuming countries to look for and develop alternatives. That is why OPEC decided afterwards to look for price stability rather than just high prices, to offer a stable and sufficient supply to consumers while ensuring a strong income to the producers.

2.3 Importance of hedging for the shale producers

A major issue in the shale oil industry is the important need for financing, as wells have rapid decline rates and producers must drill continuously if they want to produce. As seen previously, a well is mainly productive in the first operating years. To be able to secure high rates of return and attract investors, producers are heavily hedging their positions.

¹⁴ Organization of the Petroleum Exporting Countries, 2007. *OPEC*

Although the market is facing a low price per barrel, the high variety of hedging instruments being used keeps the shale industry attractive to investors. The relatively high utilization of hedging instruments is therefore specific to this market. For instance, Russia and gulf states don't secure themselves in this way as they are considered as too big to hedge. Furthermore, the market is more often on backwardation which is not suited for hedging (Appendix 1). The shale oil producers hedge their position to lock in margins. If OPEC is not considering extending the cuts anymore, oil prices will tend to decline and producers that hedged would gain out of it.

2.4 **Inventories**

Oil stockpiles can give good insights about the global state of the oil market. Inventories and oil prices tend to be highly correlated: When inventories are diminishing, one can expect that the oil price will increase and vice versa.

Therefore, this metric shows evidence of the balance between supply and demand: an excess of supply will be forcing producers to stock the surplus of quantities, and shortages will drain the inventories.

To gather information about the state of inventories, the market usually looks at the weekly report published by the U.S. Energy Information Administration (EIA). The EIA gathers inventory data on crude oil and various energy products from American companies. This report is established using the most reliable data about inventories available.

2.4.1 **Trying to reduce the inventories**

The US supply growth, linked with a lower than expected global demand for oil, led to an excess of supply that originated an oil glut that was even aggravated by the Saudi's decision to maintain production. As shown in figure 10, the market was oversupplied between 2014 and 2016. This glut is at the origin of the drop-in oil prices that began in 2014.

After two years of *laissez-faire*, OPEC announced in November 2016 that it would cut production to clear this global glut. The organisation, with external partners such as Russia, planned to cut output by 1.8 million barrels a day in an attempt to drain inventories. The cut was expected to normalize inventories and supply by the middle of

the year 2017, but the fluctuating compliance of OPEC-members, linked with the development of other producers (such as the shale industry), shows that the strategy could take much more time to succeed than the six months originally planned.

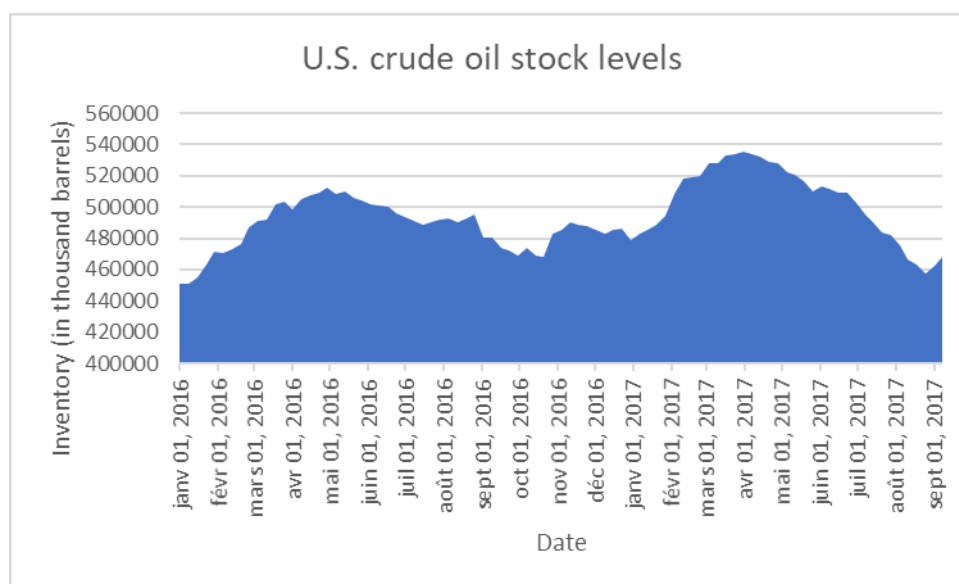


Figure 16 : U.S. crude stock levels (Source: EIA 2017)

Figure 16 shows the reported level of stockpiles in the United States. As we can see, the production cuts didn't have a significant impact on the inventory levels for the last 9 months, reducing it by only 4%.

At a more global level, as we can see in figure 17, while the stock levels are diminishing since March, we are still at higher levels than the 2012-2016 average.

Moreover, according to the International Energy Agency (IEA) : "Crude holdings drew more than twice as much as usual in June, by 15.6 million barrels to 1'194 million barrels. Most of the draw took place in the US due to

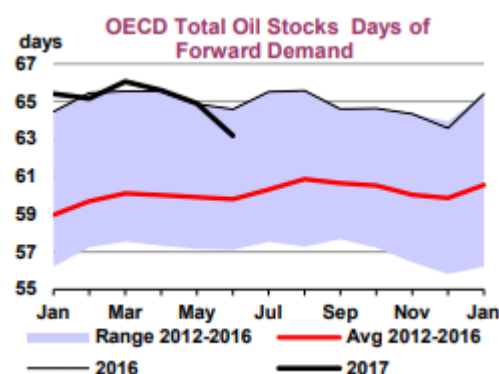


Figure 17 : OECD total oil stocks (Source: IEA 2017)

high refinery runs, which ate into crude surpluses.”¹⁵. We can assume therefore that the reduction of crude stockpiles is only partially attributable to supply reduction.

¹⁵ International Energy Agency, 2017. IEA

OPEC extended the cuts for a longer period than the 6 months originally planned and is currently discussing another extension. This would send a clear signal to the market of the cartel's determination to reach its target. But the cuts are expensive for these countries, whose finances rely heavily on oil exports. Moreover, it remains uncertain if they have the reserves to sustain these cuts.

The goal behind this inventory reduction strategy is to drive the market from a contango to a backwardation situation. The shape of the future curve, as an indicator of the changes in the oil's supply and demand balance, is an important value when trying to understand the state of the oil market.

Additionally, as shale producers hedge a much higher percentage of their production than conventional producers, the shape of the forward curve has a more important effect on the former rather than the latter.

The contango, which allows shale producers to hedge their production at a higher than spot price, ensures them to lock-in their margins in the future and allow them to reduce their price exposure, as long as price is higher than their production costs. This situation allows them to gain broader access to financing, to increase their investments and drilling capabilities and consequently, to drive the production up.

In the same time, conventional oil producers such as Saudi Arabia do not hedge their production and prefer to sell on the spot market or long-term contracts. They do not take out benefits from a contango situation.

Therefore, switching from contango to backwardation could be the solution that would allow OPEC to increase its production levels without facing a new tight oil boom.

Crude Oil Prices and Forward Curve

The slope of the crude oil forward curve and crude oil prices are closely related

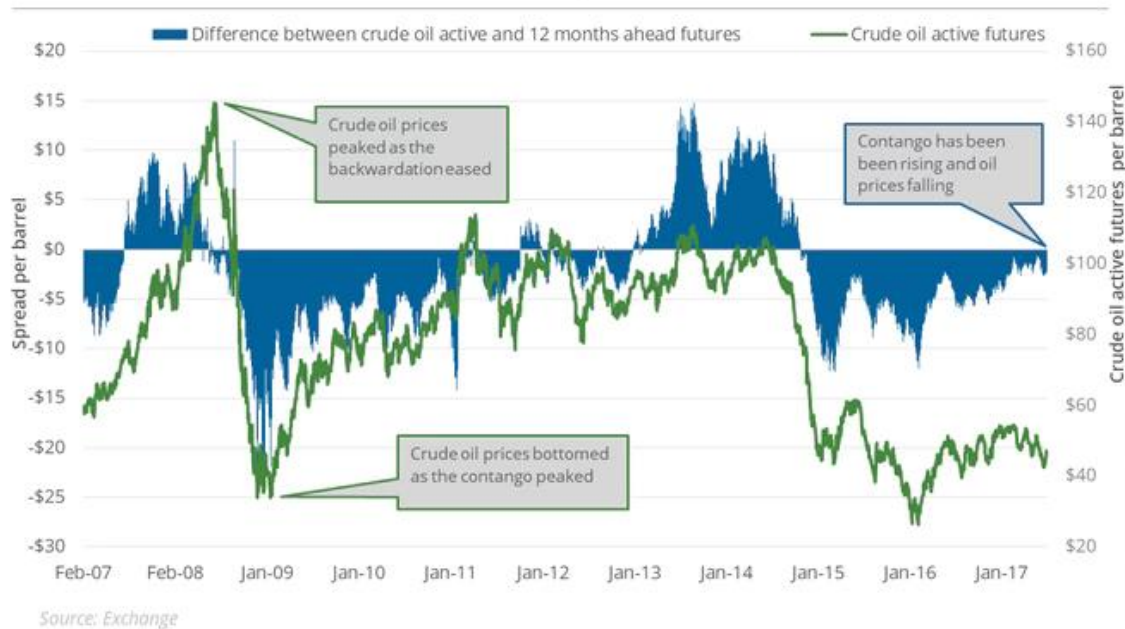


Figure 18 : Relation between contango/backwardation and crude price (Source: Marketrealist 2017)

Furthermore, as shown by figure 18, backwardation has been related in the past to high oil prices while the contango structure (and particularly the super-contango of 2008) was linked to low/decreasing oil prices.

3. Discussion

3.1 Marginal producer vs swing producer

When trying to assess the capacity of the US shale industry to act as a swing, one must differentiate the role of the swing producer from the marginal producer.

The swing producer act in the short-term to balance supply and demand on the market, by absorbing supply shocks. Its role is to flatten the price curve in the short run.

On the other hand, the marginal barrel represents the last barrel of oil sold. In basic economics, the price of a product in a competitive industry will be equal to the marginal

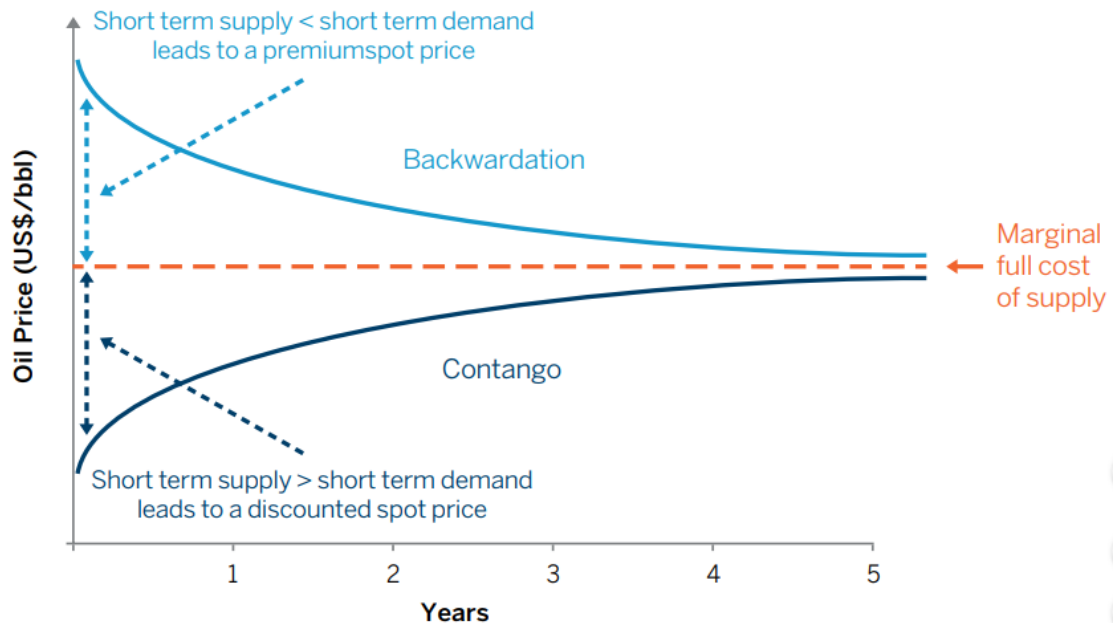


Figure 19 : Oil Price Formation: Spot Price and the Forward Curve (Source: FTI Consulting 2016)

cost of production. If we apply this principle to the oil industry, we can link the marginal producer to represent the producer for whom $\text{Price} = \text{Marginal Cost}$. Furthermore, as shown in Figure 19, long-term price of the forward curve is supposed to represent the marginal cost, plus a premium or minus a discount for delivery according to the market structure.

The marginal producer will therefore be the one who will drive long-term prices of oil.

3.2 Willingness to act as swing producer

For many analysts, Saudi Arabia's intentions to act as a price-maker is the main characteristic that allow us to call the kingdom a swing producer. But in my opinion, while it is true that it reinforced the country's influence on the market, it isn't necessary a characteristic of a swing, and the intention of acting as swing producers is not always easy to track, as oil production reports and official statements do not always represent the truth.

For example, Saudi Arabia had been officially for the last 30 years unwilling to act as swing producer, as stated by Ali Al-Naimi in 1998:

" Saudi Arabia tried in the past to play the role of the swing producer by reducing production to maintain a specific price, but the result was unfavourable to the kingdom. Even though its production fell from more than 10 million bpd in 1980 to less than 3 million bpd in 1985, prices collapsed. As a result, the kingdom not only lost in terms of

prices but also lost its market share at that time. We have abandoned once and for all the role of swing producer”¹⁶.

But it would be wrong to think that the country did not act to balance the market and establish what it considered to be the “fair price” of oil. The country participated actively in the last cuts agreed by OPEC, in 2008, 2001 and 1998.

On the other hand, the US shale industry cannot be qualified as willing to act as a swing producer. The industry is constituted of many small producers that are pursuing profitability and have the intention to maximize output at each price levels.

3.3 A new landscape in the oil business

The shale energy revolution reshaped the market considerably and it will surely have a significant impact in the long term. The surprising adaptation of the industry on the falling prices of 2014, leads us to think that the market has changed. and it is likely that the price per barrel of WTI won't exceed 60 USD in the short run long term prices around production costs (currently in the 52-53usd range)..

Moreover, the OPEC's decision to waive its swing producer status during the 166th meeting in November 2014, evidences the market transformation. Indeed, the cartel's decision to hold the same production levels, shows its resignation, at least in the near future, to let the market drive the barrel price. The inefficiency of the current OPEC's production cut to reduce inventories and lower the prices in a more comfortable situation for the member states, that struggle to set their fiscal budgets at current price levels, leads us to think that the U.S. are the new swing producers in the oil industry and not only marginal producers. OPEC's member states face the previous issue since they set their fiscal budget according to what was considered as a fair price for the market in 2012 and 2013 between 100 and 120 usd/barrel. The fall in price levels in 2014 significantly reduced their revenues that rely heavily on oil income for their budget balance.

Currently, the shale industry has more characteristics of a standard oil producer than the other oil producers. It takes much less time for shale producers to bring new barrels on the market than for other producers and the data are evident. According to the Goldman

¹⁶Reuters, 2017.

Sachs research group, a shale producer needs approximately 14 days to bring those new barrels to the market. On the other hand, conventional producers may need up to 10 years between capital commitment and production start in the case of deep water projects. That been said, an oil price increase attracts instantly new investors in the industry that will quickly bring an increase in the production capacity. The total production level can be rapidly adjusted depending on the market conditions. By comparison, a traditional production process requires significantly higher investments, particularly in the case of an off-shore production where the production level is less modulable once online.

3.3.1 A less-cartelized market

Presently, the market tends to behave as a free market: a lot of buyers and sellers are entering the market. It is the very first time that we see the oil market acting like a free market.

The market's supply curve is much flatter today (appendix 4). Previously, if the opec added or removed barrels in the market, it had a much higher impact because no one was able to react quickly and bring or withdraw new barrels to compensate. The significant amount of time that is required to start a new project and the incapacity to modulate the production levels of existing wells didn't offer an optimal situation to adapt to the market. Now, with the shale industry booming, the situation has changed. It is unlikely that OPEC has a sufficient impact on the market to influence the prices sustainably.

The market is therefore operating in a much more liberalized manner nowadays. If opec wants to take back its swing producer status, it should bring together a large number of producers. This is what they did by inviting Russia, that is not a member country, to follow the cut to reduce the global production cut even more. Nevertheless, it looks difficult if not impossible that OPEC achieves this objective: this would imply that the organization negotiates with more countries, that don't especially have the same interests as the cartel, and this would harm even more the control on the production cuts. The market mechanisms are going to behave as in a competitive market in the coming years.

3.4 Trade flow Changes

3.4.1 A glut in the U.S. oil market

The important increase in the crude oil production in the US is a game changer in the pricing mechanism of oil, with the us shale industry becoming the new swing. But it is

also reshaping the trade flows of oil: by adding nearly 5 million barrels per day of light sweet crude in the U.S. market, shale created new challenges to the oil market, in the U.S. for sure, but also in the global market. This new supply created a glut of light sweet in the U.S. market. Transportation and refineries were not prepared for this sudden increase. First, existing transportation infrastructures were not adapted to transport crude from U.S. inland production fields to refineries that are mainly located in coastal regions. The transportation bottleneck created a steep discount for the U.S. benchmark WTI in the years 2010-2011 compared to the European Brent, as shown in Appendix 1, creating price arbitrage opportunities. Ultimately, new infrastructures helped to reduce price gaps but highlighted a new problem: refineries in the U.S. are mainly designed to handle medium to heavy types of crudes and are not able to process the increasing amount of light sweet that shale wells typically produce. Therefore, one would suggest exporting the barrels in excess during the time that the refining industry needed to adapt itself to this new situation. But the export ban that was in place since the Energy Policy and Conservation Act of 1975 forbade the exports of crude from the U.S. to another place than Canada, who took profit of this supply of cheap light crude. The Canadian were at the time dependent on light crude imports because the heavy oil produced in the country needs to be blended with lighter crude in order to flow through pipelines.

Therefore, as we can see in Figure 20, nearly all the U.S. exports of crude oil went to Canada. And many voices called for a lift of the export-ban that was harming the U.S. oil producers by distorting prices and creating market inefficiencies.

U.S. Exports of Crude Oil

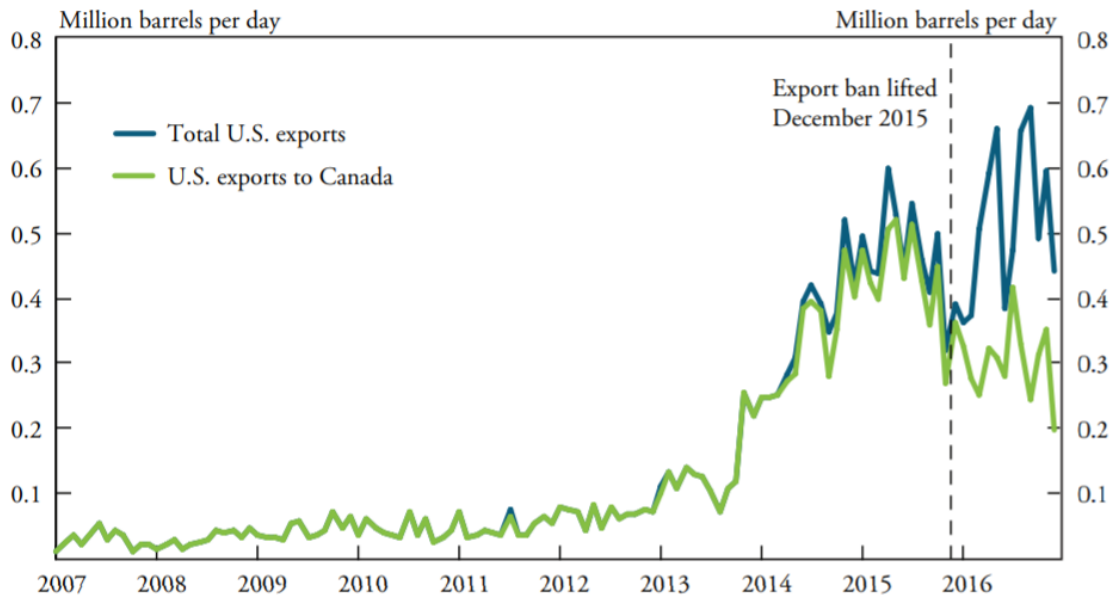


Figure 20 : U.S. Exports of Crude Oil (Source: Federal Reserve Bank of Kansas City 2017)

3.4.2 The US lift the crude export ban

In December 2015, the U.S. Congress lifted the export ban, and the result did not take long to appear. The Brent-WTI spread decreased sharply as shown in Appendix 1, the U.S. exports increased to as high as 0.7 million barrels per day and the export destinations diversified dramatically, showing that the market is gaining efficiency from the lifting of the ban.

3.4.3 Reshuffling of the Cards

One of the biggest impact of the shale revolution and the recent developments of the global oil market is the rebalancing of the worldwide trade flows of oil, starting with the United States.

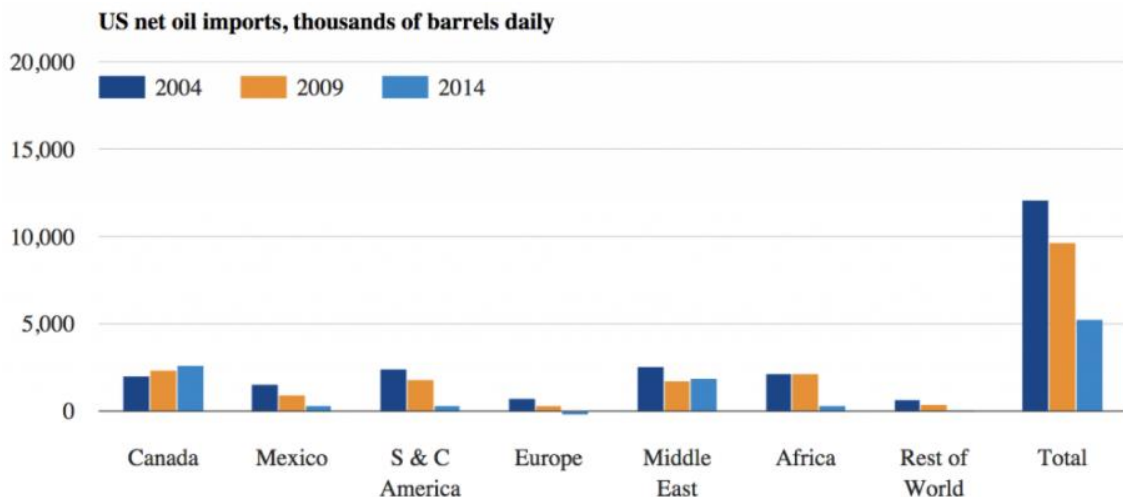


Figure 21 : US net oil imports, thousands of barrels per day (Source: Carbon Brief 2016)

Figure 21 shows the evolution of oil imports in the United States from 2004 to 2014. The graph highlights first the dramatic decrease of total imports in the country, and the reshaping of the oil sources. We can see that the country reduced its imports from most of the regions of the world except for Canada, even becoming a net exporter of oil to Europe.

The country is now less dependent on high risk country such as African and Latin American countries. This means a higher energy security for the country as well as an improved trade balance for the US economy.

For the exporting Countries on the other side, the rise of the United States as an oil exporter, linked with the current supply glut and the low prices bring new challenges. As shown in Appendix 2 and figure 22, oil trade flows, particularly from the middle east, are shifting from western countries to Asia. The second point that we can see in appendix 2 is the increasing of complexity of the oil trades around the world.

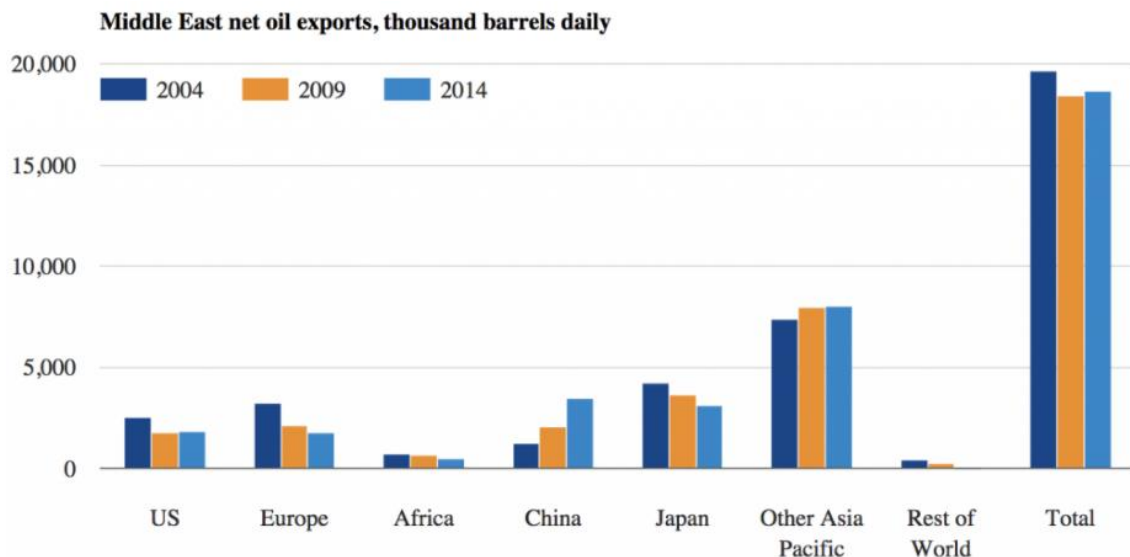


Figure 22 : Middle East net oil exports, thousands of barrels per day (Source : Carbon Brief 2016)

This can be attributed in our opinion to two factors:

First is OPEC's strategy of reducing OECD inventories and second is targeting more sustainable consumers of oil, as western countries are reducing their oil consumption due to efficiency gains and political incentives to push for an energy transition.

The first point is linked to the visibility of the western countries inventories. Stockpile levels are more reliable and published more frequently in western countries, particularly in the United States, where data are published on a weekly basis. Therefore, they have a higher impact on the oil price than Asian stockpiles that are not published officially and are usually difficult to evaluate. By shifting exports from these developed countries to Asian countries, particularly China, OPEC try to reduce these highly visible inventories.

The second point is more linked to OPEC's need of keeping a high market share in the countries that will account for most of the demand growth in the future. Oil consumption in Europe is slowly declining since the middle of the 2000's, and the current trend of reducing fossil fuels needs let us think that Europe's oil imports could never recover.

3.5 **A few thoughts on the future of oil prices**

At the time of redaction of this paper, WTI futures for next month delivery trade at around 50\$/bbl. Due to the new market conditions linked with the status of shale as swing producer, and as stated earlier, it appears unlikely to us that the WTI price will break

through the 60\$/bbl in the short-run, due to remaining high inventories and excess of supply. But in the mid-term run (until 2019), several factors will be important to monitor:

- The growth of global demand
- The capacity and willingness of OPEC to sustain or extend its production cuts
- Potential other supply disruption
- The evolution of shale industry, particularly its capacity to sustain low cost production

While we must be cautious when making price forecasts, it appears clearer and clearer that the status of shale as swing producer is likely to create a strong resistance to price increase, at least for the next 2 to 3 years.

Distribution of Bloomberg commodity analyst survey for Brent crude oil 3Y ahead (on April 1st, smoothed with kernel density estimator)

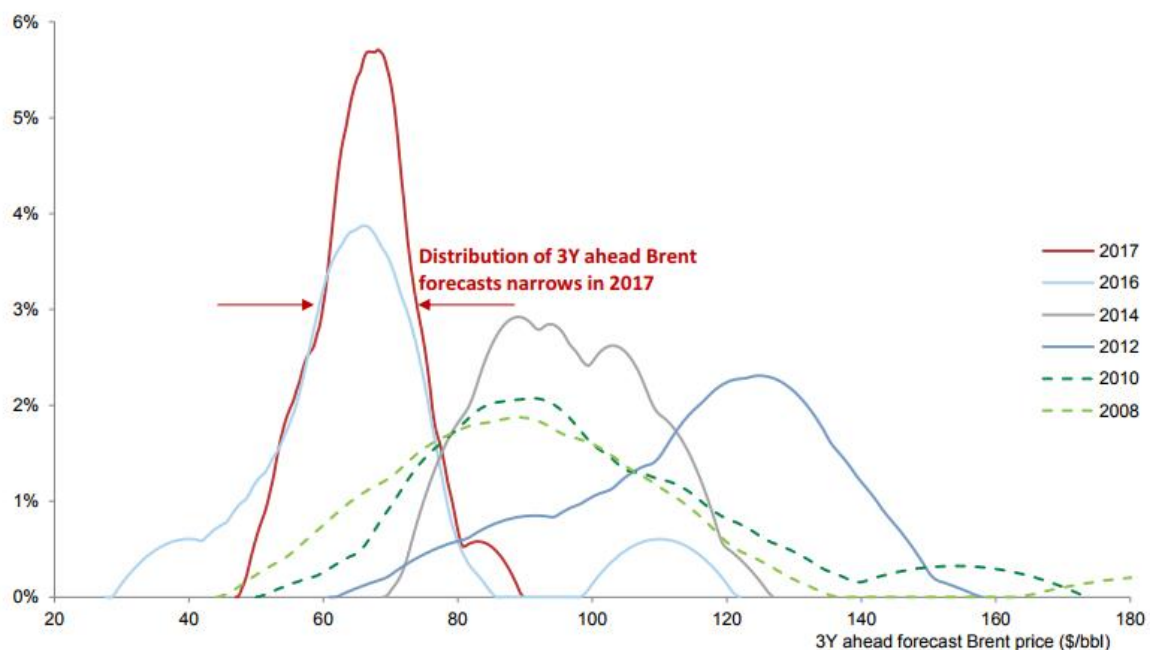


Figure 23: Distribution of 3 years ahead Brent forecasts (Source: Goldman Sachs 2017)

As we can see in Figure 23, a majority of analysts foresee the Brent price to be in a 50 to 80 usd/bbl range in 3 years from now, and the forecasts are narrowing from year to year if we compare to previous estimations. That means that the market is more and more conscious of the role of shale as swing producer.

4. Conclusion

When assessing if the shale oil industry has effectively become the swing producer of the oil market, we must look at how it managed to deal with the challenges it faced in the past three years, which it did surprisingly well:

The Industry demonstrated its capacity to not only survive in a low-price environment, but also show signs of development

When prices fell in fall 2014, many analysts forecasted that shale production would crash. While total output effectively decreased slowly until late 2016, it recovered and reached new records in august 2017, proving that it is now profitable in the current price environment.

Today, shale represents 4.75 million barrels per day, more than Iraq or Lybia

The high market share needed to endorse the role of swing producer is also reached by the shale industry. But even more important than that, shale represents today the dominant technology in the oil market.

Shale has the capacity to ramp-up production quickly in response to price signals, much quicker than conventional oil producers

The short time period between investment and production (weeks vs years for conventional projects) allows it to react quickly to market signals, bringing stability to oil prices.

The industry defeated OPEC in the price War of 2014-2016

The price war started by the cartel in 2014 turned to the advantage of the shale industry, as OPEC's countries suffered heavily from the fall in prices. For example, Venezuela is on the verge of bankruptcy, and other, more solid countries still face huge public deficit. In an attempt to slash inventories and push prices higher, OPEC put in place a production cut in late 2016, but with little success so far. While it is expected to be reconducted for 2018, some countries already announced that they could not continue to cut their production anymore. This leads us to think that the previous swing is not anymore.

For these reasons, we think that the shale industry is indeed the new swing producer of the oil market.

The impact of the shale revolution on the oil market goes far beyond the status of swing producer, it has a profound impact on the dynamics of the oil market:

Shale changed the trade flows of oil durably, bringing more complexity for sure, but allowing for new opportunities

The reduction of the US need for foreign crude forced conventional producers to look for new ways of selling their oil, with OPEC redirecting their exports to Asian countries. The oil glut in the country also brought challenges for the transportation and refining industries while creating new opportunities for arbitrage.

It put a ceiling on price that is at least going to last a few years in our opinion. The oil market is now in a situation that looks like the one we had in the 80's

As the supply curve flattened in recent years, it appears unlikely that the price of oil will come back any soon to the high levels that we have seen in the past ten years. The market will be most likely well supplied in the next years to come, but we might see a slowing of the supply in the longer run.

A lack of investment in more expensive projects could lead to a reduction of supply in a long-term horizon, which may bring a new “high prices” cycle as the one we saw in the years 2008-2014

Low prices forced producers to cut investments in new conventional projects, and strong demand growth could lead to a tighter oil market after 2020.

The global need to reduce fossil fuels consumption to fight against global warming may bring the world to a “peak demand” scenario

The energy transition that is pushed forward to fight against greenhouse gas emissions, illustrated by the efficiency gains and the development of substitutes for oil may result in the global demand for oil peaking before the supply. While this scenario is unlikely to happen before 2025 or 2030, it will still have a strong impact on the oil market: Oil producing countries would have to diversify their economies, and the industry must start to address this possibility.

In summary, it appears evident for us that shale is the new key-player in the oil market. It reshaped the oil market in such an important way, and will continue to do so in the next years, that underestimating it when analysing the oil market would be a mistake.

We hope that this work may prove useful to people interested in the recent development of the oil market, and would like to thank all those who participated to its elaboration, by their support and advices.

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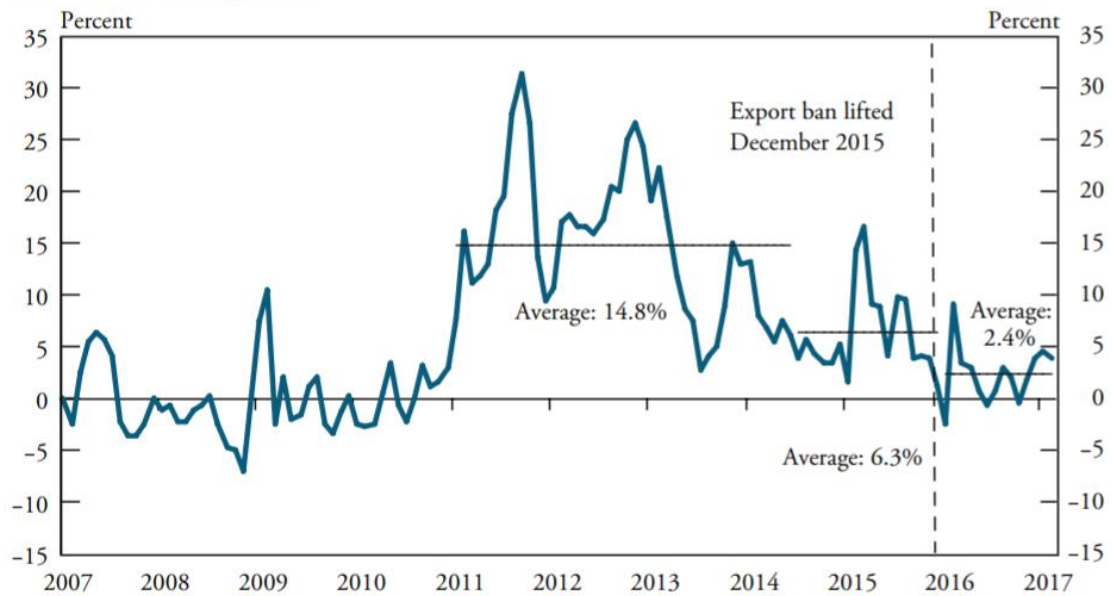
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Appendix 1: Brent-Wtl spread

Brent-WTI Spread



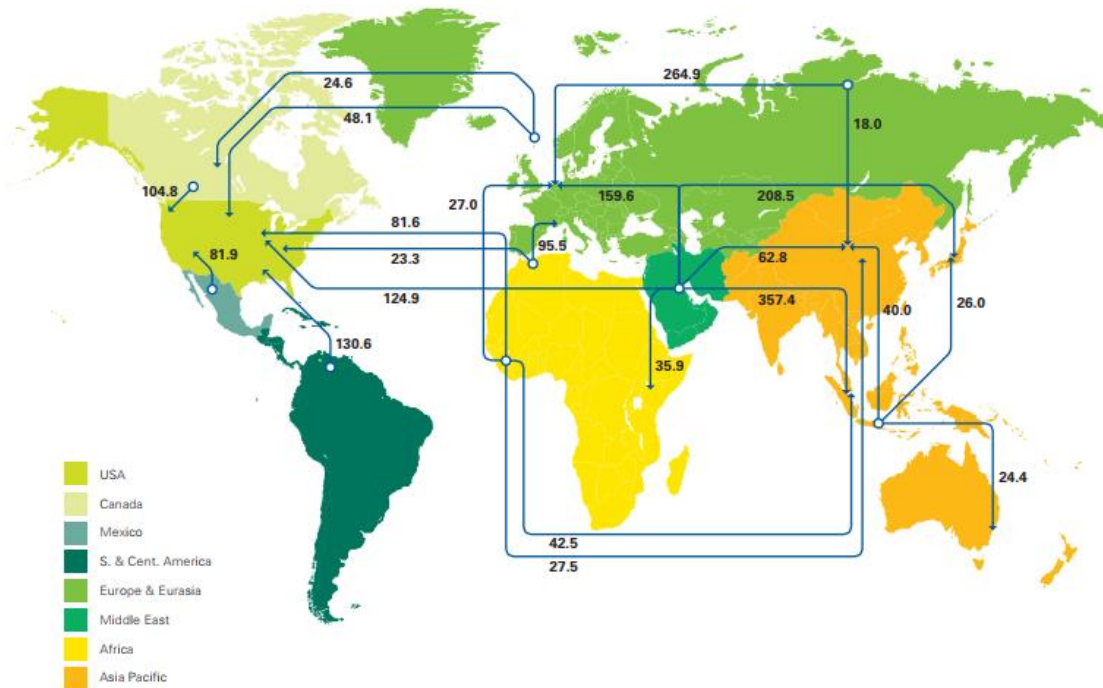
Source: Bloomberg.com 2017

Appendix 2: Major trade flows of oil, 2004/2016

Comparison

Major trade movements

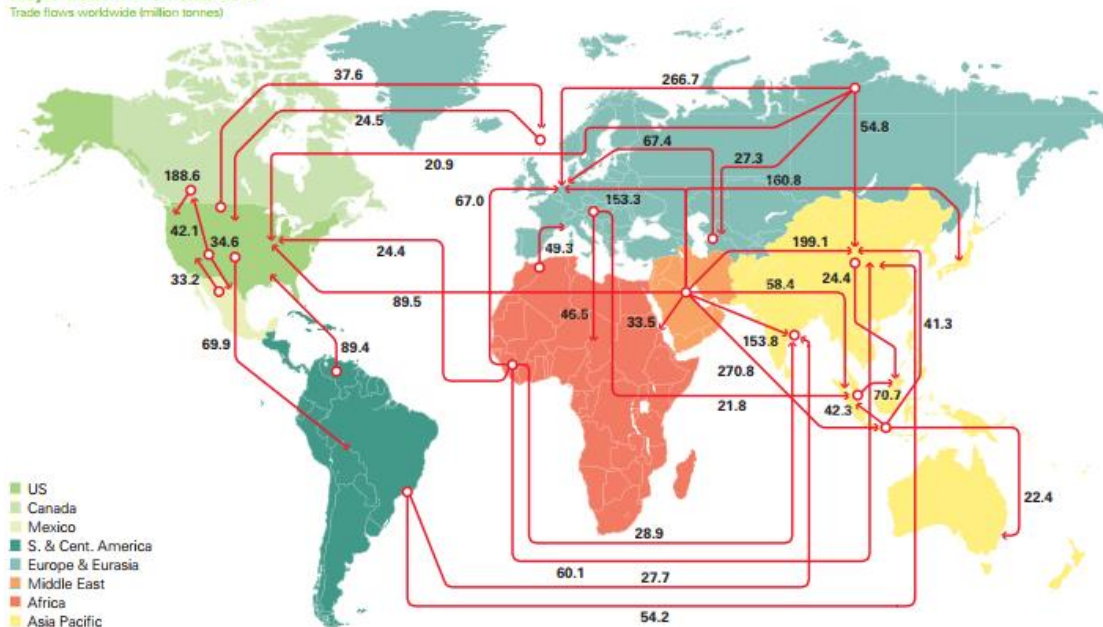
Trade flows worldwide (million tonnes)



Source: BP statistical review of world energy 2005

Major trade movements 2016

Trade flows worldwide (million tonnes)



Source: BP statistical review of world energy 2017

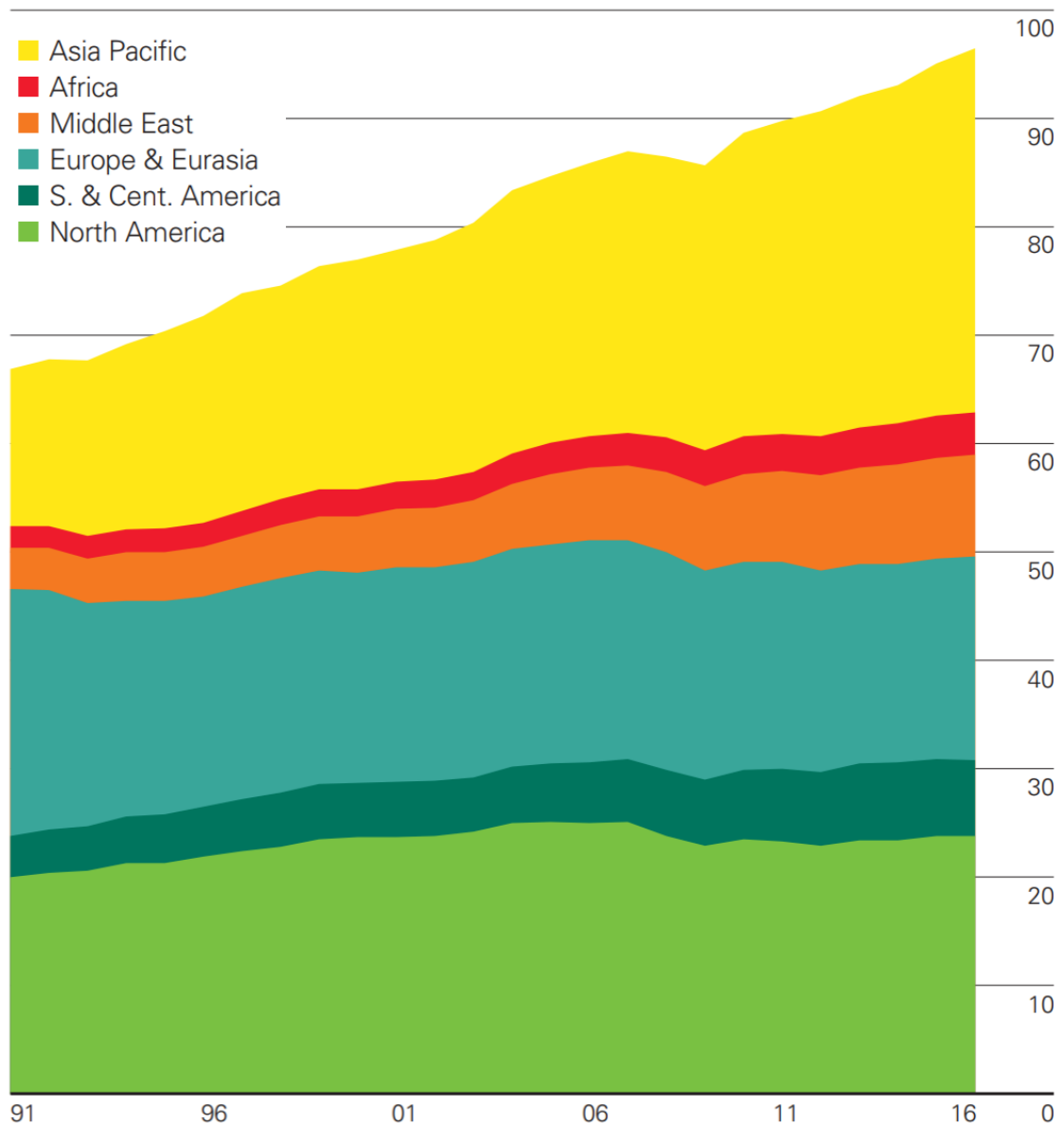
Shale, the new oil swing producer?

Gregory HUTIN

Appendix 3: Global oil consumption (in million barrels per day)

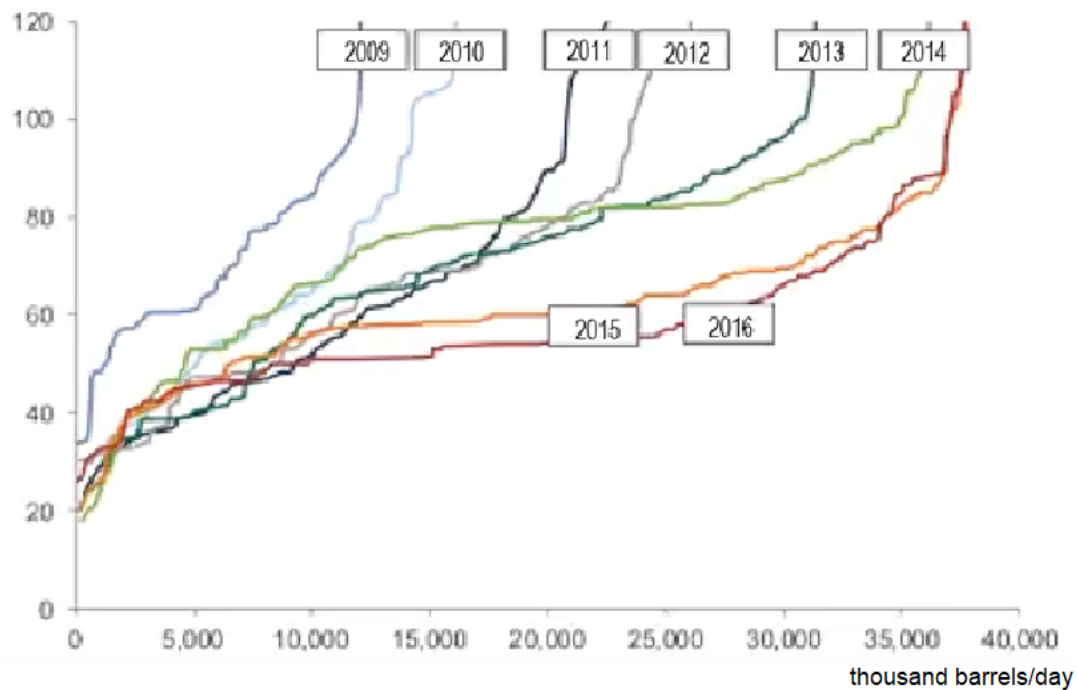
Oil: Consumption by region

Million barrels daily



Source: BP statistical review of world energy 2017

Appendix 4 : Breakeven cost of non-plateau oil assets, US \$/barrel



Source: Goldman Sachs Global Investment Research (2015)